National Institute of Environmental Health Sciences

The influence of future non-mitigated road transport emissions on regional ozone exceedences at global scale

Author(s): Williams JE, Hodnebrog T, van Velthoven PFJ, Berntsen TK, Dessens O, Gauss M, Grewe V, Isaksen ISA, Olivié D, Prather MJ, Tang Q

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Abstract:

Road Transport emissions (RTE) are a significant anthropogenic global NOx source responsible for enhancing the chemical production of tropospheric ozone (O3) in the lower troposphere. Here we analyse a multi-model ensemble which adopts the realistic SRES A1B emission scenario and a "policy-failure" scenario for RTE (A1B_HIGH) for the years 2000, 2025 and 2050. Analysing the regional trends in RTE NOx estimates shows by 2025 that differences of 0.2-0.3TgNyr-1 occur for most of the world regions between the A1B and A1B_HIGH estimates, except for Asia where there is a larger difference of ~1.4TgNyr-1. For 2050 these differences fall to ~0.1TgNyr-1, with shipping emissions becoming as important as RTE. Analysing the seasonality in near-surface O3 from the multi-model ensemble monthly mean values shows a large variability in the projected changes between different regions. For Western Europe and the Eastern US although the peak O3 mixing ratios decrease by ~10% in 2050, there is an associated degradation during wintertime due to less direct titration from nitric oxide. For regions such as Eastern China, although total anthropogenic NOx emissions are reduced from 2025 to 2050, there is no real improvement in peak O3 levels. By normalizing the seasonal ensemble means of near-surface O3 (0-500m) with the recommended European Commission (EC) exposure limit to derive an exceedence ratio (ER), we show that ER values greater than 1.0 occur across a wide area in the Northern Hemisphere for boreal summer using the year 2000 emissions. When adopting the future A1B_HIGH estimates, the Middle East exhibits the worst regional air quality, closely followed by Asia. For these regions the area of exceedence (ER>1.0) for 2025 is ~40% and ~25% of the total area of each region, respectively. Comparing simulations employing the various scenarios shows that unmitigated RTE increases the area of exceedence in the Middle East by ~6% and, for Asia, by ~2% of the total regional areas. For the USA the area of exceedence approximately doubles in 2025 as a result of unmitigated RTE, with the most exceedences occurring in the southern USA. The effects across the various regions implies that unmitigated RTE would have a detrimental effect on regional health for 2025, and potentially offset the benefits introduced by mitigating e.g. international shipping emissions. By 2050 the further mitigation of non-transport emissions results in much cleaner air meaning that mitigation of RTE is not critical for achieving the defined limits in many world regions.

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Resource Description

Climate Scenario : ☑

specification of climate scenario (set of assumptions about future states related to climate)

Special Report on Emissions Scenarios (SRES), Other Climate Scenario

Special Report on Emissions Scenarios (SRES) Scenario: SRES A1

Other Climate Scenario: A1B

Exposure : ☑

weather or climate related pathway by which climate change affects health

Air Pollution, Unspecified Exposure

Air Pollution: Ozone

Geographic Feature: ☑

resource focuses on specific type of geography

None or Unspecified

Geographic Location: ☑

resource focuses on specific location

Global or Unspecified

Health Impact: ☑

specification of health effect or disease related to climate change exposure

General Health Impact

Mitigation/Adaptation: ☑

mitigation or adaptation strategy is a focus of resource

Adaptation

Model/Methodology: ☑

type of model used or methodology development is a focus of resource

Exposure Change Prediction

Resource Type: ☑

format or standard characteristic of resource

Research Article

Timescale: ☑

time period studied

Medium-Term (10-50 years)

Vulnerability/Impact Assessment: ☑

resource focus on process of identifying, quantifying, and prioritizing vulnerabilities in a system

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